CHARACTERIZATION OF FILLED EPOXY THIN FILM COMPOSITES FOR DIELECTRIC APPLICATION

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CHARACTERIZATION OF FILLED EPOXY THIN FILM COMPOSITES FOR DIELECTRIC APPLICATION

by

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Master of Science

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DECLARATION

I hereby declare that I have conducted, completed the research work and written the dissertation entitles "Characterization of Filled Epoxy Thin Film Composites for Dielectric Application". I also declare that it has not been previously submitted for the award of any degree or diploma or other similar title of this for any other examining body or University.

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LIST OF ABBREVIATIONS

PCB	Printed Circuit Board
CMC	Critical Micelle Concentration
$CaCO_3$	Calcium Carbonate
$BaTiO_3$	Barium Titanate
CNT	Carbon Nanotube
SWCNT	Single-walled Carbon Nanotube
MWCNT	Multi-walled Carbon Nanotube
BSTZ	Barium Strontium Titanate Zirconium
Ag	Silver
Al	Aluminium
DGEBA	Bisphenol-A Diglycidylether
PMMA	Polymethyl Methacrylate
PTFE	Polytetrafluoroethylene
Triton X-100	Polyoxyethylene Octyl Phenyl Ether
SDS	Sodium Dodecyl Sulfate
CTAB	Cetyltrimethylammonium Bromide
AMPTES	3-(Aminopropyl)triethoxysilane
GPTMS	3-Glycidoxypropyltrimethoxy Silane
H_2O_2	Hydrogen Peroxide
CO_2	Carbon Dioxide
DI	Deionized Water
TEM	Transmission Electron Microscope
HRTEM	High Resolution Transmission Electron Microscope
SEM	Scanning Electron Microscope

DSC	Differential Scanning Calorimetry
DMA	Dynamic Mechanical Analysis
FTIR	Fourier Transform Infrared Spectroscopy
TGA	Thermogravimetric Analysis
DTG	Derivative Thermogravimetric
TMA	Thermomechanical Analysis
CTE	Coefficient of Thermal Expansion

LIST OF SYMBOLS

Q	Charge
V	Voltage
C	Capacitance
ε	Permittivity of the Material
ε_0	Permittivity of the Vacuum
k	Dielectric Constant
A	Area
d	Separation between Two Conductors
t	Thickness of the Specimens
V_f	Volume Fraction of Filler
V_m	Matrix Volume Fraction
W_f	Weight of Filler
W_m	Weight of Matrix
$W_{surfactant}$	weight of surfactant
W_{AMPTES}	weight of AMPTES
ρ_f	Density of Filler
ρ_m	Density of Matrix
E_f	Filler Modulus
E_m	Matrix Modulus
E'	Storage Modulus
E''	Loss Modulus
I_D	Intensity Ratio of D Band
I_G	Intensity Ratio of G Band
T_g	Glass Transition Temperature

T_5	5 % Weight Loss Temperature
T_{onset}	Onset Degradation Temperature

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PENCIRIAN KOMPOSIT FILEM NIPIS EPOKSI TERISI UNTUK KEGUNAAN DIELEKTRIK

ABSTRAK

Dalam kajian ini, sifat dielektrik, mekanikal dan terma komposit filem nipis epoksi terisi pelbagai jenis pengisi telah dikaji. Bahan pengisi dan epoksi disediakan dengan menggunakan pencampuran ultrasonik dan komposit filem nipis difabrikasi dengan kaedah lapisan putaran. Dalam peringkat petama, komposit filem nipis epoksi terisi mineral kalsium karbonat (mineral $CaCO_3$) dan kalsium karbonat termendak ($CaCO_3$ termendak) telah dikaji. Adalah didapati bahawa $CaCO_3$ termendak mempamerkan sifat dielektrik dan kekuatan tensil yang lebih baik manakala mineral $CaCO_3$ mempamerkan sifat terma dan moduli yang lebih baik. Dalam peringkat kedua, sifat bagi pelbagai jenis pengisi ($CaCO_3$ termendak, barium titanat ($BaTiO_3$) and tiubnano karbon berbilang dinding (MWCNT)) telah dikaji. Adalah didapati bahawa $BaTiO_3$ dan MWCNT mempamerkan sifat dielektrik dan kemuatan yang lebih baik dibandingkan dengan $CaCO_3$ termendak. Memandangkan sifat dielektrik dan kemuatan adalah penting untuk kegunaan kapasitor, MWCNT dipilih untuk kajian kefungsian dalam peringkat ketiga. Rawatan MWCNT oleh pelbagai jenis kefungsian mengunakan polioksietilena oktil fenil eter (Triton X-100), natrium dodesil sulfat (SDS), and 3-(aminopropil)trietoksil silana (AMPTES)) digunakan untuk merawat MWCNT. Adalah didapati bahawa rawatan MWCNT mempunyai sifat dielektrik dan mekanikal lebih baik daripada MWCNT tanpa rawatan. Sifat dielektrik yang lebih kurang sama diperhatikan dalam perbandingan bagi dua jenis epoksi (OP 392 epoksi dan DER 332 epoksi) dengan 1.5 vol% MWCNT tanpa rawatan dan MWCNT dengan rawatan oleh Triton X-100 dan SDS. Komposit filem nipis OP 392 epoksi mempamerkan suhu peralihan kaca (T_g) yang tinggi dan kekuatan tensil yang lebih rendah dibandingkan dengan komposit filem nipis DER 332 epoksi. Secara keseluruhannya, komposit filem nipis epoksi terisi MWCNT dengan rawatan oleh Triton X-100 adalah bahan yan paling sesuai untuk kegunaan dielektrik.